REMARKS

Claims 1-15 and 21 are pending in the present application. Claims 1, 2, 4-15 and 21 are rejected. Claims 1 and 2 are herein amended. No new matter has been entered.

Claim Rejections – 35 U.S.C. §112

Claims 1 and 2 are amended to clarify an extent of hydrogen termination between the interface between the semiconductor substrate and the gate insulation film without using the relative term "less".

A limitation for an extent of the suppressed hydrogen termination of the interface is recited in amended claims 1 and 2 based on the result of the experiment the inventor of the present application was performed. Specifically, hydrogen termination of an interface between the semiconductor substrate and the gate insulation film is suppressed so that a fluctuation of a dispersion of hydrogen termination ratio of the interface is not more than 35% of that without the metal layer when the transistor is of N channel, and a dispersion of hydrogen termination ratio of the interface is not more than 85% of that without the metal layer when the transistor is of P channel.

In the experiment, N channel and P channel transistors with and without the metal layer having the property of occluding hydrogen were investigated regarding the dependencies of the dispersions of their threshold voltages σVth on hydrogen annealing temperature. The hydrogen annealing temperature was changed to four levels.

The attached graph shows the result of the experiment showing the dependencies of σVth on a hydrogen annealing temperature. The plot indicated by ♦ shows σVth of the N channel transistor with the metal layer. The plot indicated by ◊ shows σVth of the N channel transistor without the metal layer. The plot indicated by ▲ shows σVth of the P channel transistor with the metal layer. The plot indicated by Δ shows σVth of the P channel transistor without the metal layer.

The slopes (temperature coefficients) and intercepts on the y-axis for respective plots on the attached graph are as shown in the following table. The effect of the metal layer in the table means the ratio of the value with the metal layer to the value without the metal layer.

	the metal layer	slope	intercept
σVth of N channel transistor	with (◆)	-2.14E-06	4.18E-03
	without (◇)	-6.85E-06	5.91E-03
	effect of the metal layer	31.24%	70.73%
σVth of P channel transistor	with (▲)	-3.87E-07	2.41E-03
	without (△)	-3.83E-07	2.95E-03
	effect of the metal layer	101.04%	81.69%

Based on the experimental result, it is found that the dependency of the dispersion of the N channel transistor characteristics on the hydrogen annealing temperature is smaller with the metal layer compared to without the metal layer. Specifically, the ratio of the (temperature coefficient) with the metal layer to the slope without the metal layer is 31.24%, which is not more than 35%.

It is also found that the dispersion of the P channel transistor characteristics is smaller with the metal layer compared to without the metal layer. Specifically, the ratio of the intercept

with the metal layer to the intercept without the metal layer is 81.69%, which is not more than 85%.

Since the hydrogen annealing temperature and the ratio of hydrogen termination are in proportion to each other, the hydrogen termination ratio can be numerically represented based on the experimental result as follows.

Namely, regarding the N channel transistor, the fluctuation of the dispersion of the hydrogen termination ratio is not more that 35% of that without the metal layer. Regarding the P channel transistor, the dispersion of the hydrogen termination ratio is not more than 85% of that without the metal layer.

Claim Rejections – 35 U.S.C. §102

Claims 1, 6, 8, 10, 12 and 14 are rejected under 35 U.S.C. 102(b) as being anticipated by JP-09252131-A.

Claims 1 is amended so as to definitely state the suppression state of hydrogen termination of the interface between the semiconductor substrate and the gate insulation film using to specific values. That is, hydrogen termination of the interface is suppressed so that a fluctuation of dispersion of hydrogen termination ratio of the interface is not more than 35% of that without the metal layer when the transistor is of N channel, and a dispersion of hydrogen termination ratio of the interface is not more than 85% of that without the metal layer when the transistor is of P channel.

In the present invention according to claim 1, hydrogen termination of the interface between the semiconductor substrate and the gate insulation film by hydrogen annealing is homogeneously suppressed by the metal layer formed of a metal material having the property of occluding hydrogen. This suppression state without compensation is represent in amended claim 1 using the specific values of the fluctuation of the dispersion of the hydrogen termination ratio or the dispersion of the hydrogen termination depending on the channel type of the transistor.

Due to the suppression of hydrogen termination by the metal layer and the resultant less hydrogen termination of the interface, as represented by the specific values in amended claim 1, inhomogeneous hydrogen termination of the interface between the semiconductor substrate and the gate insulation film can be avoided, and the transistor can have high relative accuracy.

On the other hand, JP-0925231-A discloses that dangling bonds at the interface between a substrate surface and a gate insulation film are sufficiently terminated by setting hydrogen concentration of annealing atmosphere considering hydrogen amount occluded by titanium layer formed over a MOS transistor. It is probable that the sufficiently terminated state of the interface disclosed in JP-0925231-A is substantially equal to that of the interface without the titanium layer formed over the MOS transistor. It is evident that the hydrogen termination ratio of the sufficiently terminated interface in JP-0925231-A is much higher than that of the present invention according to claim 1. The MOS transistor is substantially different from the present invention according to claim 1 in terms of hydrogen termination ratio of the interface between the semiconductor substrate and the gate insulation film.

In addition, as discussed in the previous responses to the Office Actions, the invention disclosed in JP-0925231-A is related to a technique for sufficiently terminating an interface between a substrate surface and a gate insulation film when a hydrogen occluding metal layer is formed not only over a gate electrode but also near the interface. Namely, the invention disclosed in JP-0925231-A has no connection with the suppression of hydrogen termination which leads to the interface containing less hydrogen termination. It is clear that the terminated state of the interface in JP-0925231-A is exactly the opposite to that of the present invention.

As described above, the present invention according to claim 1 is substantially different from the invention disclosed JP-0925231-A in terms of the hydrogen termination ratio of the interface. Therefore, because not all of the claimed limitations are met by the cited reference, it is clear that the present invention according to claim 1 and its dependent claims 6,8,10, 12, and 14 can not be anticipated by JP-0925231-A.

Claim Rejections – 35 U.S.C. §103

Claims 2, 7, 9, 11, 13, 15, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP-0925231-A and further in view of Lockwood (U.S. Patent No. 3,996,482).

Claim 2 is amended in the same way as claim 1 so as to definitely state the suppression state of hydrogen termination of the interfaces between the semiconductor substrate and the first and the second gate insulation films using the specific values.

The same argument as argued regarding claim 1 can be applied to conclude that the present invention according to claim 2 is substantially different from JP-0925231-A in terms of the hydrogen termination ration of the interfaces.

Therefore, even if JP-0925231-A was combined with Lockwood simply disclosing multiple transistors, it is clear that the present invention according to claim 2, and its dependent claims 7, 9, 11, 13, 15 and 21 would have been unobvious to one of ordinary skill in the art at the time the invention was made, because not all of the limitations of the present invention would have been taught or suggested

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP-0925231-A and further in view of Dixit et al. (US 2002/0185664 A1).

As described above, JP-0925231-A fails to disclose all the features of the present invention according to claim 1, and it is clear that the present invention according to claim 1 cannot be anticipate by JP-0925231-A.

Therefore, even if JP-0925231-A was combined with Dixit et al. teaching the connection of dummy metal to ground, it is clear that the present invention according to claim 4 dependent from claim 1 would have been unobvious to one of ordinary skill in the art at the time the invention was made, because not all of the limitations of the present invention would have been taught or suggested

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP-0925231-A in view of Lockwood (U.S. Patent 3,996,482) and further in view of Dixit et al. (US 2002/0185664 A1).

As described above, even if JP-0925231-A was combined with Lockwood, it is clear that not all of the limitations of the present invention according to claim 2 would have been taught or suggested.

Therefore, even if JP-0925231-A was combined with Lockwood and further with Dixit et al. teaching the connection of dummy metal to ground, it is clear that the present invention according to claim 5 dependent from claim 2 would have been unobvious to one of ordinary skill in the art at the time the invention was made.

In view of the aforementioned amendments and accompanying remarks, Applicants submit that that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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